ANTENNAS FOR BROADCAST RECEPTION

BOOK 2

No. 6SB

REFERENCE BOOK

PIONEER HOME STUDY RADIO SCHOOL

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Antennas for Broadcast Reception

INDOOR ANTENNAS

Possibly the simplest and the most easily constructed indoor antenna is a single wire running up to and around the picture moulding as shown in Fig. 32. Small pins or staples can be used to hold the wire which may be concealed in the grooves of the moulding. It can be carried along the picture moulding to the diagonally opposite corner of the room, or carried completely around the four sides of the room. Excess length of antenna or other external wiring should never be stored inside the receiving cabinet. Wires should always run straight from the binding posts to the holes in the rear of the cabinet. The antenna wire should not be near other electric wires or metal electric light fixtures as losses in signal strength and the introduction of interfering noises may result.

Unless the roof of a building is of metal, an antenna can be installed in the attic. In this case two parallel horizontal wires between 25 and 40 feet long spaced about 2 feet apart can be used as shown in Fig. 33. These horizontal wires are held to the walls by porcelain knobs. Again care must be taken that these wires are not near metal pipes or electric light wires.

The ends of the two wires should be connected together with No. 18 B and S gauge interior telephone wire or some other rubber covered and braided wire directly above the place where the receiver is to be installed and this wire carried directly down to the receiving set. All joints must be soldered.

A neat installation can be made by carrying the wire through the walls so it will be completely concealed. In no case should the wire be run through a metal pipe or metal conduit. A wall receptacle and an attachment plug can be used where this antenna connecting wire comes through the wall to the room in which the receiver is located. The receiver should be placed as close to the point where this connecting wire enters the room as possible.

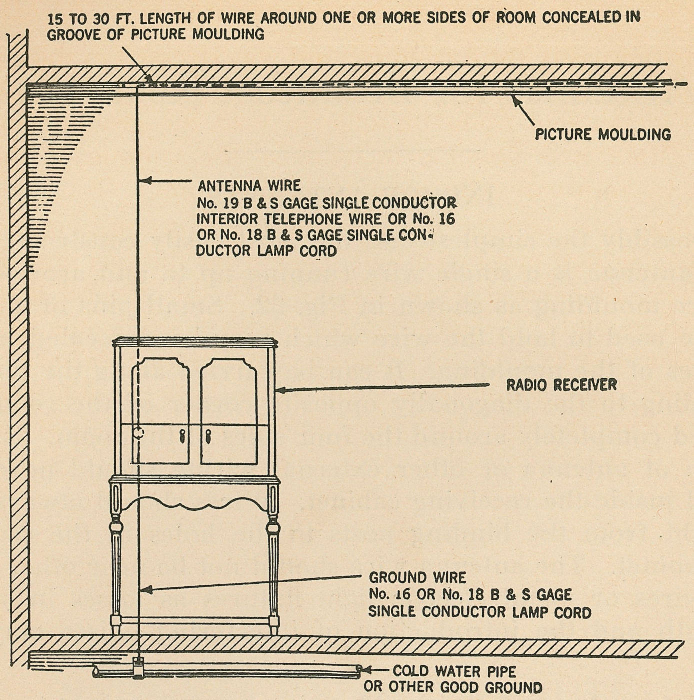


Fig. 32

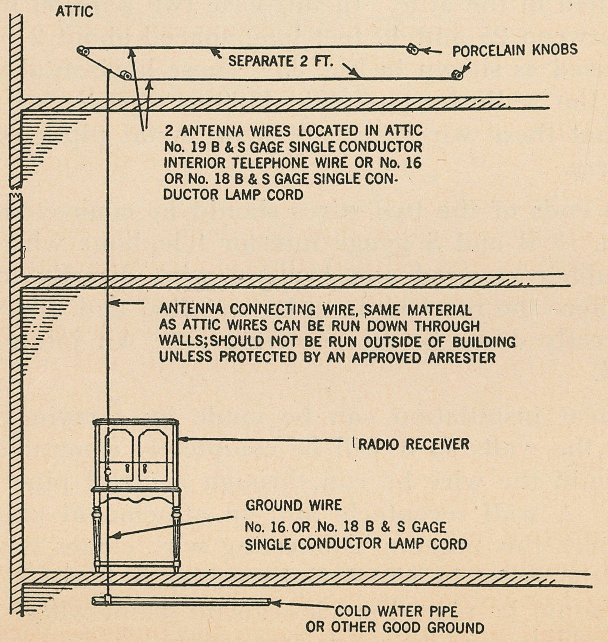


Fig. 33

GROUND CONNECTIONS

The necessity for a good ground was stressed in the earlier part of this book. The efficiency of the set as a whole is largely dependent upon the efficiency of the ground connection. Often it is possible to increase the volume of the receiver by improving the ground connection.

There are various ways of making a ground connection and the method employed will depend on the location of the receiver. In general, it is best to have the ground leads as short as possible. Avoid long wires with many bends in them from the receiver to the ground connection. Where there are water pipes handy they provide the best possible ground. A connection to the water pipe should be made by a special

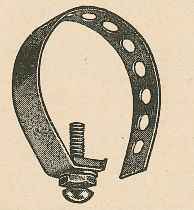


Fig. 34

ground clamp, shown in Fig. 34, which can be purchased from any electrical or radio supply jobber. The water pipe should be cleaned with a file and sandpaper, all rust and other dirt must be removed so that the clamp can make a perfect connection. The wire leading to the receiver should be soldered to the ground clamp.

If there is no water pipe available, the radiator piping system may be used. But in the country where there are no plumbing fixtures available for use as grounds, a good ground can often be obtained by driving a six foot length of heavily galvanized iron pipe into the ground until only about ½ foot remains exposed. To be effective the pipe or rod must be deep enough to be in earth that is continually moist and below the freezing level. Usually 5½ feet is deep enough, provided the soil is not sand or gravel.

To prevent a pipe from splitting when driven into the earth, it should be threaded at one end and a threaded cap or nut turned down onto it about flush with the end of the pipe. Ordinary half inch pipe will serve the purpose very well.

Sometimes this scheme is used—about 100 square feet of galvanized chicken fence wire is buried ten feet deep. Where there is no moist earth, the hole can be filled in with moistened charcoal. If fence wire is not available a fairly large piece of sheet metal can be made to serve the purpose.

Where every other kind of ground proves unsatisfactory a counterpoise may be used. This consists of a network of wires laid out like an aerial. It is best to build it 8 or 10 feet above the ground, so that it will clear any obstruction that might damage it or be damaged by it. It must be thoroughly insulated from the ground. In area, the counterpoise should cover about 50% more ground than the aerial system.

A typical counterpoise is shown in Fig. 35. Theoretically, it is one plate of a huge condenser, of which the aerial is the

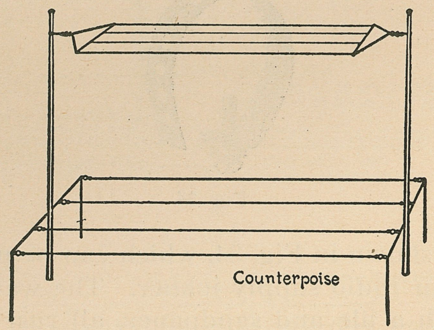


Fig. 35

other plate, just as in an ordinary installation, the aerial is one plate and the ground is the other plate.

AERIAL PROTECTIVE DEVICES

To protect the receiver from being damaged by lightning, a single-pole double-throw switch may be used. The upper terminal of the switch connects to the aerial, the central terminal to which the switch arm is connected leads to the radio set and the lower terminal is grounded. This provides a means for grounding the aerial during storms or when the set is not in use. It is usually mounted outside the building.

Another device which provides surer protection is the automatic lightning arrestor. When only a lightning switch is used there is a possibility that it will be forgotten just

when it is needed most and lightning will have a direct path into the receiver. The lightning arrestor does not require personal attention—it is entirely automatic and for this reason the National Board of Underwriters require that some approved lightning arrestor be used either in conjunction with a lightning switch or alone.

Lightning arrestors have two terminals, one must be connected to the aerial and the other grounded. Between these terminals is a gap in a vacuum. See Figs. 36-A and 36-B. This gap offers practically no resistance to the flow of very high frequency currents, such as lightning discharges, but acts as an insulator to normal operating currents. During the ordinary reception of radio signals the current flows past the arrestor through the receiver—it does not pass through the gap to the ground. But when there is a lightning discharge the arrestor offers the shortest and most direct path to the ground. Accordingly, any dangerous current is prevented from entering the receiver.

Besides this "vacuum" arrestor, which is the most popular type, there are air gap and non-air gap arrestors.

The air gap type depends for its operation on a closely spaced air gap, which offers a low breakdown voltage (550 volts). The non-air gap type makes use of a carborundum stone with a special clay binder. This type of arrestor has a rectifying action similar to that of a carborundum detector.

LEAD-IN WIRE

To comply with the Underwriters' regulations a lead-in should come through an insulated tube inserted in a hole which has been drilled through the window sill. The tube should be of porcelain and the wire must fit loosely.

There is a specially designed lead-in connector which makes the drilling of the sill unnecessary. It is a copper strip heavily insulated, fitted with connectors at both ends. This type of lead-in connector is not approved by the Underwriters and is used at the owner's risk.

When the flexible lead-in strip is used, the lead-in wire is clipped to one end and the set wired to the other. Wires must be soldered at these points, and the clip itself should be soldered to the strip if the manufacturer has not done so. Be sure that the strip is protected from the weather. Do not

use a connector of this kind through a metal window casement unless additional insulation is provided.

Some engineers maintain that the best lead-in is the aerial lead wire itself. This can be brought into the house, without the necessity of drilling any holes, in this manner—slip a short length of bare varnished tubing over the wire just where it passes over the window sill, and jam the window down on it. Of course it will flatten out and be practically a strip protecting the lead-in wire. Insulators on both sides of the sill should be used.

The best of all, however, is to bring the lead-in wire directly through the wall. Home owners do not object to telephone wires being brought through the wall. Learn the secret of neat workmanship and you will be allowed to do

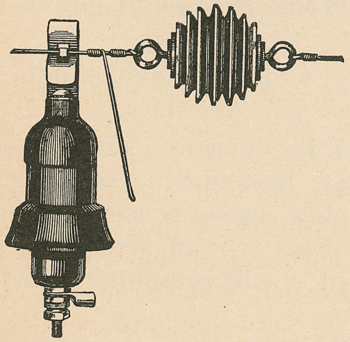


Fig. 36-A

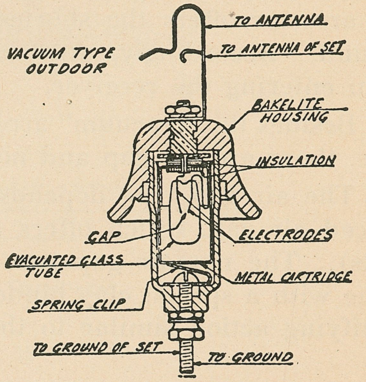


Fig. 36-B

likewise. A sample of how the final job will look, at your workshop, will convince customers of your ability. A good aerial installation demands careful work. It isn't hard to convince a customer of this fact, and once convinced he will be willing to pay a little more for a real job.

Where the receiver is in an interference zone, special care must be given to the lead-in. The aerial may be a perfect one, of the proper height and the proper length, away from interference, yet if the lead-in wire passes through zones of interference set up by high power tension lines, or electrical apparatus of various kinds, all the good qualities of the aerial will be nullified.

Where a problem of this sort arises, the use of lead covered lead-in wire is usually a good solution. The lead covering acts as shielding for the lead-in wire and prevents interfering currents from mixing with the signal currents. Where a lead covered lead wire is used, a lead covered ground wire should be used also. The lead covering of both may be grounded. Sometimes it is advisable to ground the shielding through a 10,000 to 100,000$^{\omega}$ resistor. One thing that must not be forgotten is to construct the lead-in wire in such a way that when it rains no water will get inside the lead sheathing. This is vitally important as water will quickly ground the whole antenna system.

Lead covered wire may be obtained from any electrical supply house. This shielded lead-in has been found particularly valuable for apartment house dwellers who are required to use very long lead-ins. With a long lead-in a very short aerial must be used to obtain even a fair degree of selectivity. But by using lead covered wire for the lead-in it is possible to use an aerial of the proper length.

AERIAL AND GROUND TESTING

When in doubt as to the efficiency of an aerial installation, test it for leaks. An ohmmeter placed across aerial and ground should show infinite D. C. resistance. A "B" battery in series with a high resistance voltmeter will do just as well. When in doubt as to the pick-up ability of the aerial, hang a 30 to 50-foot insulated flexible wire out of the window (be sure that the far end is taped) and use it as the aerial. Unless the permanent installation is superior and results in greater signal strength we can assume that the permanent aerial is defective.

Where radiators are used as grounds, it is advisable to connect the radiator piping system to the water pipe system if possible. A network of grounds is not objectionable if all the connections are well made. Before connecting two grounds together a continuity test with an ohmmeter will indicate by a low resistance reading that both grounds are good. Where D. C. socket powered receivers are being installed it is wise to place a one mfd. condenser rated at a working voltage of 400 in the ground lead.

AERIAL SUBSTITUTES

Strictly speaking there is no substitute for a good aerial and where space permits and local conditions are such that

"man made noise" is not present, use an aerial of the conventional type.

But of course a Radio-Trician must know every angle of his chosen profession. So, realizing that any aerial other than the conventional type is really a makeshift, we go on to study light socket antennas, built-in antennas (see Figs. 37 and 38) and in this chapter we shall also consider ball and underground antennas which though not strictly makeshift, cannot be counted on to be as satisfactory as the aerials previously described.

Fig. 37

There are many devices on the market by means of which the electric light wires can be used as antennas. They are in the shape of a plug which contains an ordinary condenser having a mica dielectric. When the plug is inserted the condenser is in series with the house wiring. Only one side of the line is used.

The object of the condenser is to prevent the grounding of the current flowing in the line without opposing the passage of high frequency radio currents through the condenser to the receiving set.

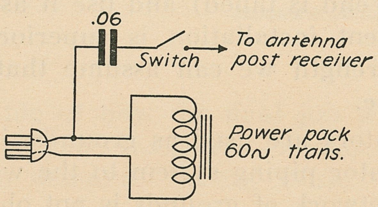


Fig. 38

Devices of this kind are frequently built into radio receivers in which case a switch is provided so that this built-in antenna may be instantly available.

Another type of antenna, which is really an aerial because it is erected in the air, is the ball antenna pictured in Figs. 39 and 40. The ball is made of non-corroding aluminum alloy, approximately 10 inches in diameter. It has a conductive surface of about 346 square inches, and in this respect is claimed to be equivalent to a 75-foot wire aerial. Its capacity is centered in one spot. Three 12-foot guy wires are connected directly to the ball but insulated from the roof of the house. The ball rests on a condenser consisting of two parallel plates. The dielectric is ¼ inch of non-conductive material (bakelite).

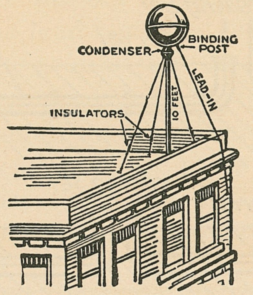


Fig. 39

The upper plate is connected directly to the ball and likewise to the lead wire. The lower condenser plate connects directly to the steel pole on which the ball, itself, is mounted. The guy wires are also connected to the lower condenser plate and act as a supplementary energy collector, feeding radio energy to the antenna through the condenser. The lower plate acts as a ground.

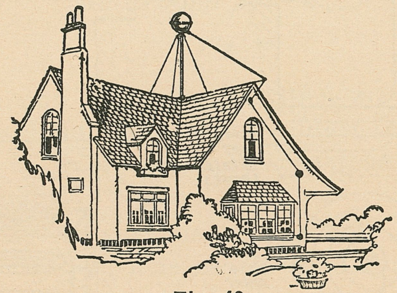


Fig. 40

The use of a ball antenna will in some degree reduce interference, but as always signal strength is reduced at the same time. In localities reasonably near broadcasting stations they may prove very satisfactory. They may be placed as close as 10 feet apart without interfering with each other. They do not have any directional properties as the same amount of conductive surface is exposed in all directions.

The underground antenna for which great claims were

made involves the same problems as the ball antenna and at the same time is much more difficult to install. Interference is appreciably cut down—but so is the signal strength.

In Fig. 41 details of an underground antenna installation are shown. A lead sheathed insulated copper wire is buried

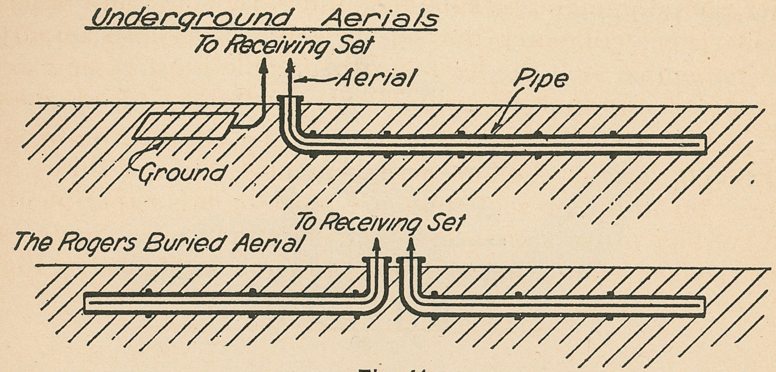


Fig. 41

in a straight trench 2 feet deep and possibly 100 feet long. The lower portion of Fig. 41 shows the underground antenna invented by Dr. Rogers whose laboratory in near-by Maryland was the scene of much radio research during the World

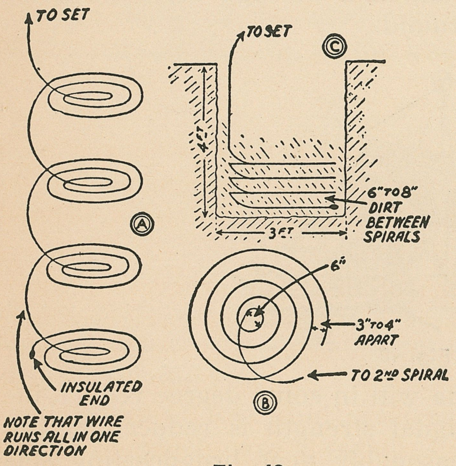


Fig. 42

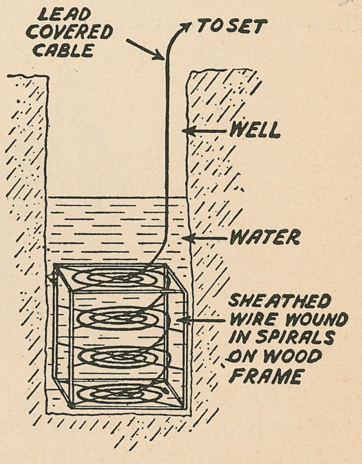


Fig. 43

War. These antennas are directional just as straight wire aerials are.

Figure 42 shows how an underground antenna can be arranged with the least amount of labor. A lead sheathed

wire is wound in several spirals and these spirals are buried in the earth, each separated from the other by a layer of soil. The whole assmbly is covered and may be kept moist if necessary. This antenna may be used under water as well as under ground. Then the method of installation is as shown in Fig. 43. It is very necessary that a set used with an underground antenna be shielded, otherwise static and other interference will enter the set directly. It is also important to remember that the lead sheathed cable must extend as far as the set and that the ground wire must also be lead covered.

Much thought has been given to the elimination of static through various antenna arrangements. Most of these, however, up to the present time, are more or less experimental—they may prove satisfactory and they may not. Some radio servicemen claim that a double antenna as shown in Fig. 44

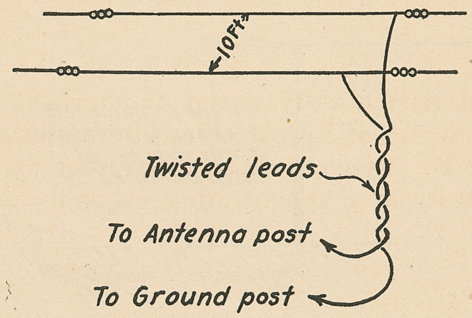


Fig. 44

will eliminate any interference which may be picked up in the antenna itself but here again it must be remembered that any decrease in interference is accompanied by a decrease in signal strength.

When using an antenna of this type no ground wire is necessary—the system acts as an oscillatory circuit. One of the wire terminals leads to the antenna post of the receiver, the other to the ground connection. Figure 45 shows a scheme which would prove very satisfactory in cases where there is a source of interference near by. This installation requires considerable space and so cannot be adapted for use in cities where space is at a premium. The antenna itself may be erected several hundred feet away, out of the direct interference zone. Lead covered lead wire is used which runs from the aerial to the house, underground.

When a hook-up of this sort is used it is advisable to make the antenna larger than would ordinarily be required and to connect a .00025 to a .001 mfd. condenser, preferably variable, in series with the antenna lead. An XL vario-denser or a similar device may be used. It will help to bring the signal strength up nearer normal and also serve to reduce the added capacity introduced by the lead-in shielding. A substitute for lead covered lead-in wire may be had by using well insulated wire run through BX cable.

In all installations in which lead covered wire is used, special care must be taken to prevent the lead covering from touching other metallic objects. When bringing the lead-in down from the antenna use "Nail-tite" knobs and stand-off insulators.

Another unusual antenna installation is shown in Fig. 46. This is really a substitute for an underground antenna.

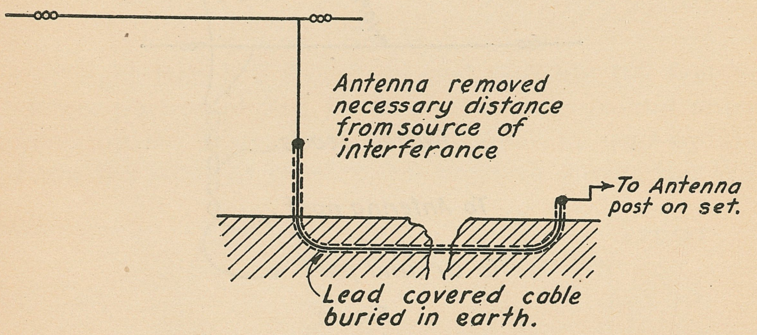


Fig. 45

A regular inverted L type of antenna is erected. No. 10 rubber covered wire is used. Around this rubber covered wire is wound a suitable length of regular antenna wire, with turns about 2 inches apart. The regular antenna wire is continued at the far end of the aerial to provide a ground connection. The winding continues up to about 6 inches from the receiver. There must be no electrical contact between the two wires.

The effect of an installation of this kind is peculiar. The antenna may be anywhere between 10 and 50 feet high. Yet in effect it is underground. This trick hook-up does not always work but it is worth trying when every other has failed. Many Radio-Tricians keep one of these antennas made up, with the bare copper wire coiled about the rubber covered wire, and carry it along in their tool kits when they go out on a job.

Many screen grid receivers both of the tuned radio frequency and the superheterodyne types are so sensitive that fairly good reception can be obtained with the use of an antenna built right into the receiver, especially where steel was not used in the construction of the home or building in which

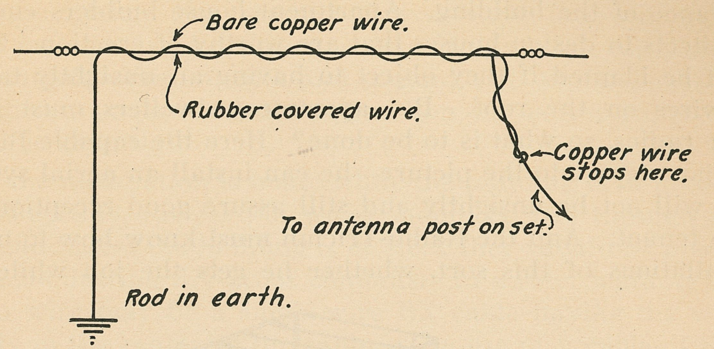


Fig. 46

the receiver is used. In fact many commercial receivers are built with local antennas for convenience.

Built-in antennas are capacity antennas, that is, current flow is induced in them by the "electro" part of the electromagnetic wave. Two types of capacity antennas are shown in Fig. 47.

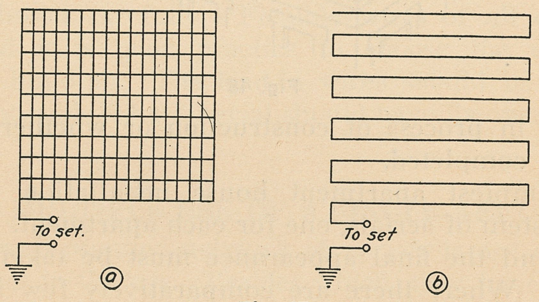


Fig. 47

Where these are used the receiver is provided with a special binding post or switch for connecting or disconnecting the built-in antenna. That manufacturers do not place a great deal of confidence in built-in antennas will be clear if you read their instructions carefully. They recommend their use only for local station reception.

APARTMENT HOUSE AERIALS

The problem of apartment house antenna installation is a big one. A great many things have to be taken into consideration in order to provide each apartment with satisfactory reception without undue interference and at the same time have an installation that will not detract from the appearance of the building. Apartment house builders employ architects to design houses that are worthy of erection. They can't be blamed if they object to having an unsightly tangle of wires on the roof. But apartment dwellers must have their radios, so what is to be done? Here the capable Radio-Trician steps into the picture—he can install an aerial system that will not be unsightly and still assure good reception for each tenant. And the Radio-Trician must know how to make installations of this sort, whether he gets the job while the

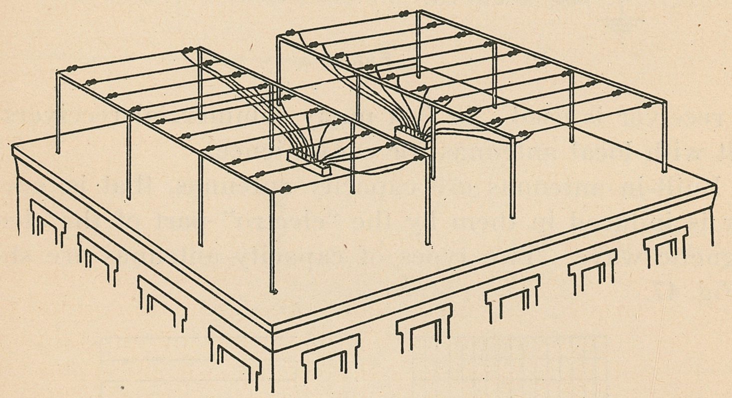


Fig. 48

building is in process of construction or whether it has already been completed.

The simplest apartment house installation is a well-planned system of aerials, one for each apartment. The space available and the final appearance must be taken into consideration. Where there are comparatively few apartments a network of aerials as shown in Fig. 48 may be used. The wires are parallel to each other and for this reason the arrangement is not ideal; interaction between receivers is possible and a regenerative receiver will be a real nuisance if operated on one of the aerials. However, not many regenerative receivers are in use today and if the Radio-Trician finds one, a "blooper" as it is called, he should take advantage of this opportunity to make a sale of a modern receiver.

Each lead-in wire should be kept separate unless the apartment house has considerable steel in its construction in which case other means must be found to take care of distributed capacity. The lead wire should be brought to an aerial and ground wall plate placed conveniently in the living room* and the ground from the cold water pipe brought to the same plate. For greatest convenience, the wall plate should include a socket power outlet. If this is not convenient or permissible the antenna and ground wall plate should be near the A. C. power outlet; provision for power supply to the set is essential.

If the installation is made while the building is in process of construction, the lead-in wires should be run through the walls and unless the building is of steel, they should be placed in non-conducting fire-proof conduits. In a steel building the lead-in wire may be a single-wire BX cable having the wire directly in the center of the cable. The use of a cable of this sort is bound to add parallel capacity to antenna systems and so their natural wavelength will be raised. To compensate for this, a .001 mica condenser can be connected in series at the outlet box which is behind the wall plate. The use of BX cable permits the running of several lead-in wires close together. The metal sheathing itself may be grounded.

Where permission can be obtained, ordinary outside lead-ins are desirable. If used, stand-offs, insulators and wire should be chosen carefully. Flexible wires of all colors are available and it is good practice to choose the color that matches the building. The lead-in wires should be as inconspicuous as possible. Each aerial should have its own lightning arrestor.

THE MULTIPLE USE OF A SINGLE AERIAL

Even a well-planned network of aerials is not extraordinarily pleasing to the eye. Besides which, they have technical limitations. And so it was natural that engineers gave this phase of Radio considerable attention.

A firm of consulting engineers† developed a system which makes use of a well-known principle of telephone transmission, technically known as the "loaded line" principle.

*Receivers should be placed so that the sound will travel the greatest distance forward without striking walls. Corners are ideal if the room layout permits. Considerable thought to correct receiver placement is well worth-while.

†Amy, Aceves & King, Inc., 55 W. 42nd St., New York City.

Figure 49 shows an aerial and ground connected to a loaded line. This arrangement is equivalent to a single inductance and capacity connected in parallel or in series (L_a—C_a) whichever is most convenient. A voltage E is induced into the aerial by a Radio wave. For this reason the arrangement may be considered a voltage generator, having an internal impedance, feeding a load. To obtain maximum power the internal impedance should be balanced by an external load impedance.

The sketch is self-explanatory—an inductance is split in the center and the condenser C is connected between it and the ground. A load resistance R is placed across the antenna and ground at the far end so that the high frequency current actually reaches the end of the system and allows each condenser to draw an equal amount of current. At each point X a radio receiver is connected. The receiver is grounded as shown. This arrangement is known as the multi-coupler system and each split inductance and its associated condenser is called a multi-coupler (see Fig. 50). An 80 microhenry coil, tapped in the center, and a 250 micro-microfarad condenser are used. The end resistance is between 500 and 1,000 ohms. One to 15 receivers may be used on a single aerial in this way. However, reception is best when only 8 or 10 receivers are connected to it.

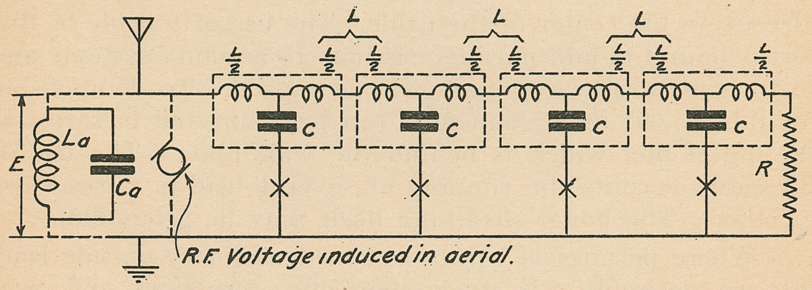


Fig. 49

The following specifications refer to the installation of the multi-coupler antenna system for erected buildings where the aerial downleads carrying the multi-couplers are located in the court, in the air shaft or in the dumbwaiter shaft.

For satisfactory operation of this system, the following equipment is essential and must be installed according to the specifications outlined below:

A—Adequate antenna for every 15-20 apartments.
B—Series multi-coupler for each apartment.
C—Terminal resistance for each antenna.

A:—A single wire aerial 75 to 100 feet long, using standard copper aerial wire No. 14, at least 25 feet above the roof is required for every feeder line or downlead. This antenna should be as high as possible and clear from any obstacles, such as chimneys, metal smoke stacks, guy wires, etc. The support to which the antenna wire is fastened should be of neat construction, preferably of the pipe assembly type as shown in Fig. 51 and should not be less than 8 feet in height if the antenna wire is not strung directly across the roof so that the aerial wire and insulator are well out of reach. An approved lightning arrester should be installed for each aerial in accordance with the requirements of the Board of Fire Underwriters.

In case it is impossible, due to limited roof space, to erect a single wire aerial 75 feet long in a straight line, satisfactory results can be obtained by using an aerial made up of several sections connected together so that a total length of 75 to 100 feet may be obtained as the roof conditions permit. If several individual aerials are required on the same roof, no two aerial wires should be parallel to each other unless separated by at least 8 feet.

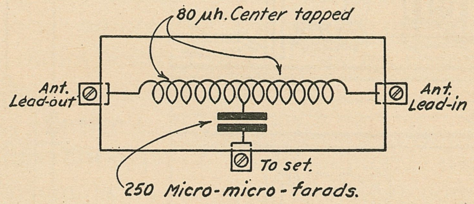


Fig. 50

B:—For each aerial, a downlead supported by a strain insulator fastened to the top of the parapet wall in the court of the building is required. This downlead is held out from the wall of the building at least 5 inches by means of a standoff insulator which is located at each apartment a few inches under the multi-coupler.

The downlead wire should be of standard phosphor-bronze aerial wire No. 14 and must be supported at the top and bottom by strain insulators, as indicated in detail in Fig. 51. The insulated eye-screw must be of heavy galvanized iron or bronze in order to withstand all weather conditions for a number of years and remain free from rust. These insulators are to be fastened to the brick wall, using a Rawl plug in a ¼ inch hole

drilled ¾ inch deep in the brick and not in the mortar between the brick.

At each floor a multi-coupler is inserted in the downlead just below and to the right of a living room window. The

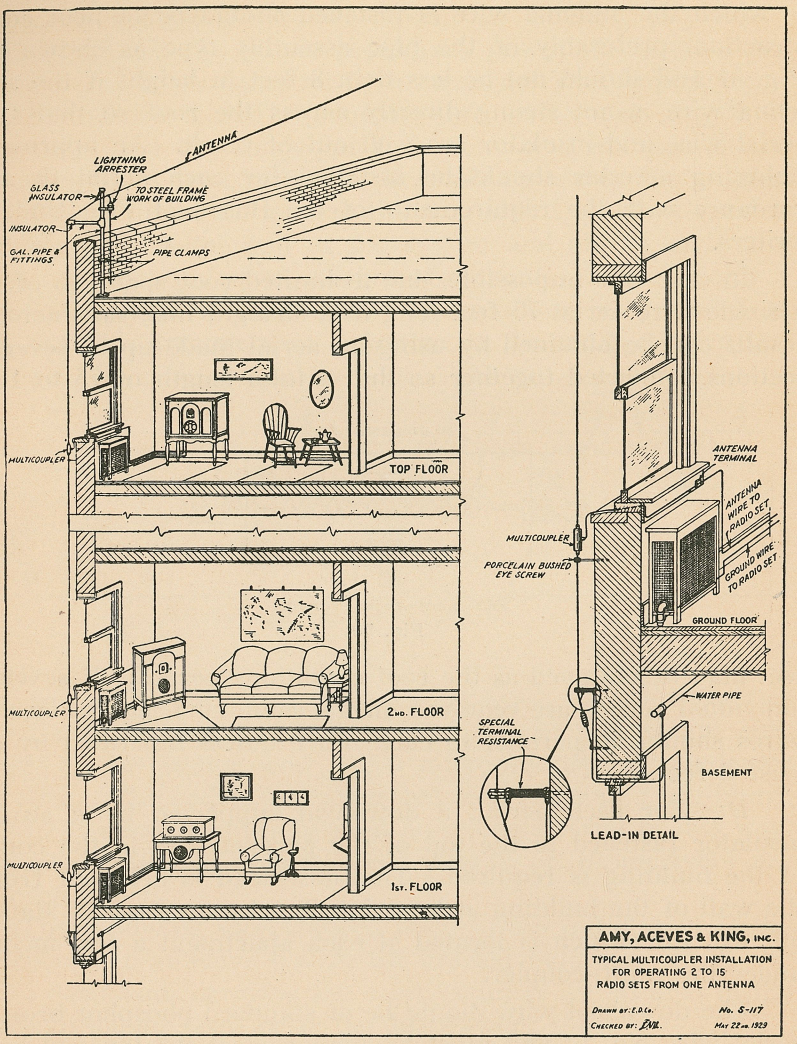


Fig. 51

side terminal or binding post of the multi-coupler is connected to the radio set in each apartment. The lead-in making this connection is brought to the terminal block by means of a thoroughly weather-proofed wire through a 3/16 inch hole in

the window-sill. From the terminal block, an inconspicous wire may be run along the molding to the radio set.

C:—For each antenna a terminal resistance unit, connected between the end of the downlead and a good ground such as the water pipe, are required. This unit consists of a weather-proof non-inductive resistance of 750 to 1,000 ohms having a rating of 30 watts.

After the completion of each antenna with its associated multi-couplers, it is suggested that a continuity test be made with an ohmmeter on the roof connected between the antenna and a suitable ground to measure the resistance of the circuit. The value should be the same as that of the terminal resistance inasmuch as the resistance of the multi-couplers is negligible.

The installation of the multi-coupler antenna system made in accordance with these specifications is approved by the New York Board of Fire Underwriters.

The following specifications refer to the installation of the multi-coupler antenna system for buildings in the course of construction,* where the wiring is concealed in conduits with a radio outlet located in each living room.

The equipment essential to the satisfactory operation of this system is similar to that required for the outside type except that a different type of multi-coupler is used and all wiring of the system is enclosed in electrical conduits.

The general type of installation may be either one of two arrangements as indicated first by the typical riser plan with living room outlet box containing multi-coupler as shown to the right of Fig. 52 and second, the alternate arrangement of riser plan having as many as five outlet branches for each apartment, shown to the left of the drawing. The latter arrangement is found highly desirable in the case of duplex or triplex apartments, especially of the cooperative type where it is usually found desirable to have three or more radio outlets in various rooms of one apartment.

The following equipment is essential for the proper operation of the system:

A—Suitable antenna.

B—Series multi-coupler for each apartment.

C—Conduit system.

D—Terminal resistance for each antenna.

*The installation service company should prepare installations under the supervision of Amy, Aceves & King, who manufacture and supply the installation equipment.

A:—A single wire aerial should be used, like the one described in the section under "A" on page 17.

However, unless the antenna is at least 40 feet high and 100 feet long, it is recommended that not more than ten apartments be energized from one aerial wire in the conduit. For

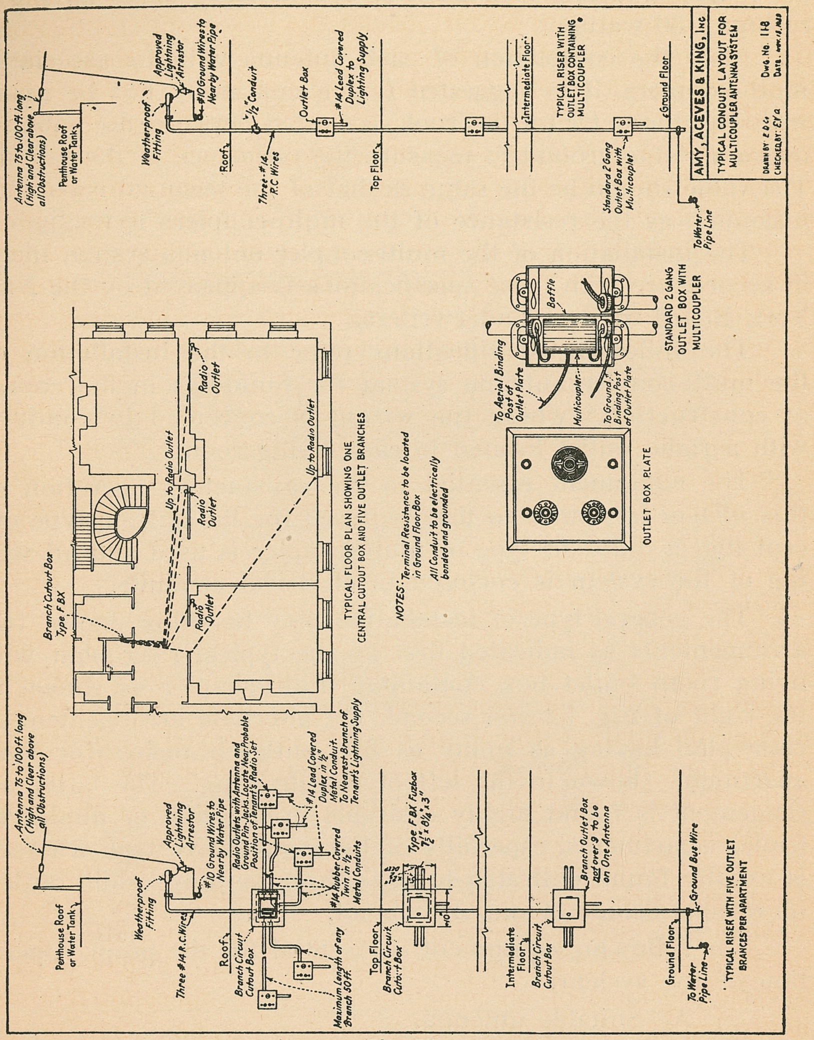


Fig. 52

an apartment house of sixteen or more stories, it is recommended that two aerial leads be used in the same conduit, each aerial with its downlead serving eight apartments, one aerial for the even numbered floors and the other for the odd.

B:—For each apartment a separate indoor type multi-coupler is required and must be located either in the branch cut-out box or in the wall outlet box as indicated in Fig. 52, depending on the type of riser installation desired.

C:—All inside conduit regardless of the riser system used as indicated on drawing attached is to be ½ inch standard metal. Three straight No. 16 insulated wires of different colors are to be used in each vertical riser conduit, one of these wires to be used as a common ground bus for the riser and associated radio sets, this wire to be grounded in the basement to the nearest water pipe. The other two wires are to be used as aerial feeder lines. One multi-coupler for each apartment is to be placed in series with one of these feeder lines. It is recommended that not more than ten multi-couplers be operated from any one feeder line. In the case of an apartment building of eighteen floors, it is suggested that one riser wire be used for the even numbered floors and another riser for the odd.

The conduit riser system in general may be either of the two types shown in Fig. 52, depending upon the size and type of the building in which the system is to be installed. For large apartments of the duplex type where it is desired to have the facility of transferring the radio aerial connection to any one of five rooms from a main cut-out box, the *Branch Riser System* is recommended. For apartment houses where the living rooms of the apartments are in a vertical row, the *Simple Vertical Riser System* is recommended, with the radio outlet box located in the wall of each living room. For this type of riser installation, the multi-coupler is inserted in the radio outlet consisting of a standard 4 inch x 4 inch box with 1¼ inch cover and wall plate with duplex current tap and aerial and ground jacks.

In the Branch Riser System, a special type FBX fuse box is used for each apartment placed in the conduit riser in some inconspicuous location, such as a closet, pantry, or hall. From this branch outlet box as many as five radio outlets placed in various rooms of an apartment may be operated from a small plug switch arrangement located in this box. The boxes of these FBX units may be furnished in advance and installed along with the associated conduit and wiring. After the construction work in the building is advanced and the plastering is finished, the apparatus is to be inserted in these boxes, connected, and put in operation.

D:—For each antenna, a terminal resistance unit connected between the end of the downlead and ground, such as a water pipe, is required. This unit consists of a special non-inductive resistance having a rating of 30 watts, and is to be mounted in a 4 inch x 4 inch metal box with blank cover located in the basement at the end of the conduit line.

RCA CENTRALIZED ANTENNA SYSTEM

Another antenna system, probably more involved than the one just described, has been developed by the RCA-Victor Company, Inc. The unique features of this system are:

1—High signal intensity.
2—Total absence of interaction between receivers.
3—The elimination of the pick-up of interfering electrical noises of the distributing system.
4—Efficient transmission of all signals at all frequencies in the broadcast band at the same time.
5—Economy, considering results and cost of maintenance.
6—Ease of installation.

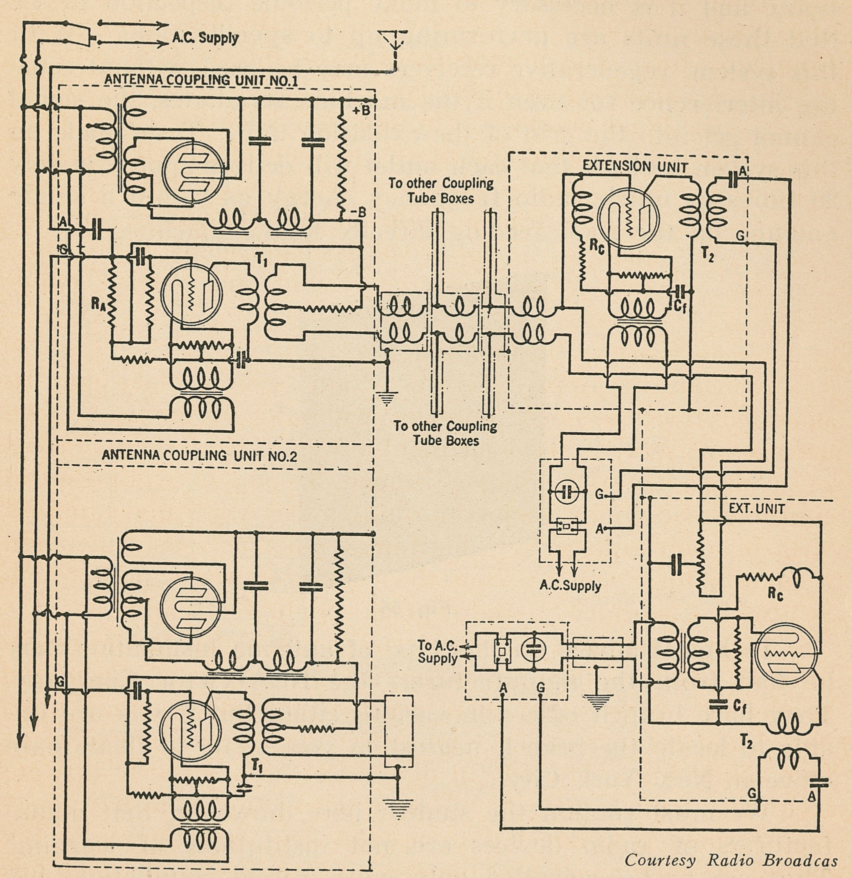
A maximum of 80 receivers of any type or make may be operated from a single antenna without interference. Two aerials will serve a 160 apartment-house. The system consists of a single aerial feeding a branch of one to eight central coupling assemblies, each containing a 226 A. C. tube supplied with filament voltage by a built-in step-down transformer and a plate voltage supply from the central power supply which is also incorporated in the central coupling assembly.

Referring to Fig. 53, the aerial is connected to the resistance R_A which is then fed to the grid by means of a coupling condenser. Notice that there are two antenna coupling units Nos. 1 and 2 shown in series and there may be as many as eight in a single row. The output of the 226 tube is fed to a radio frequency transformer T_1. The output of the radio frequency transformer is connected to a two-wire feed line in a BX cable. At each apartment there is an extension unit which has built into it a 226 tube, the filament of which is supplied by means of a local A. C. step-down transformer, and whose plate is supplied from the central supply unit, the voltage being transferred over the wire.

The plate of the extension unit has a transformer, T_2, the terminals of which act as the aerial and ground. These lead to the wall plate which also contains the A. C. power outlet

and an off-on switch which controls the antenna system and the A. C. lines. See Fig. 54.

The transmission line is really a loaded line, quite similar to the one already explained and it is essential that the inductance and capacity effects of this line be kept in balance. Every 20 feet a loading coil is placed in the circuit to compensate for the distributed capacity in the shielded lead wires to each apartment. This is shown in 56-B, marked RFL.

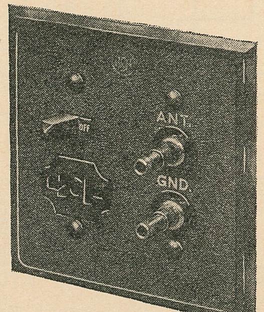


Courtesy Radio Broadcas

Fig. 53

Each antenna coupling unit supplies 10 extension units as a maximum. The extension unit is embedded in the wall of each apartment with the plate easily removable for repairs within the coupling and for replacement of the 226 tube. The centralized coupling system as well as the extension unit must be placed in metal boxes to comply with the local underwrit-

er's rules. A general layout is shown in Fig. 55. An impedance is placed at the last receiver so that the radio frequency energy will be uniformly distributed to all extension units in that particular antenna coupling line-up. Figure 56-A shows an antenna centralized unit, with the necessary B supply for the entire extension. Figure 56-B shows an extension unit which is located, as we have said, in each apartment. The antenna coupling system is located usually on the roof in the pent house and it is necessary to make periodic inspection to see that these units are performing up to specifications. With this system, regenerative receivers may be used without causing interference for even if the machine reradiates, the signal cannot get into the grid of the extension unit. Tests made on this system indicate that each outlet will deliver approximately 20 times as much radio frequency energy as would a single antenna on the roof, feeding directly to the machine.



Courtesy R C A-Victor Co.

Fig. 54

Technical advice on this type of antenna installation may be had from the manufacturer—the RCA-Victor Company. They have branch offices in various cities, but if you are unable to locate the branch nearest to you, write to their main office in New York City.

We must caution the student here, however, that manufacturers of radio devices are not institutions of learning. They are to be consulted only when actual installations are being considered.

FIRE UNDERWRITERS' REGULATIONS FOR RADIO EQUIPMENT

General.

a. The requirements of this article shall neither apply to equipment installed on shipboard, nor to antennae used

for coupling carrier current to line conductors; but shall be deemed to be additional to, or amendatory of, those prescribed for general electrical installations.

b. Transformers, voltage reducers, keys and other devices employed shall be of types expressly approved for radio reception or transmission.

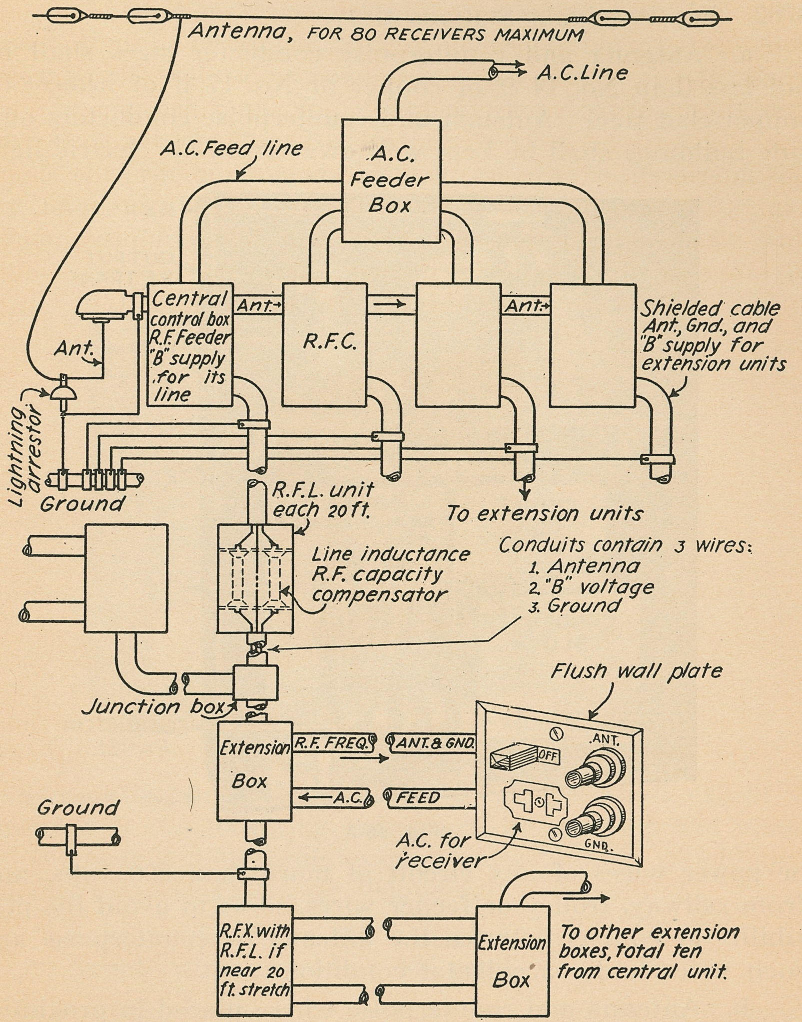


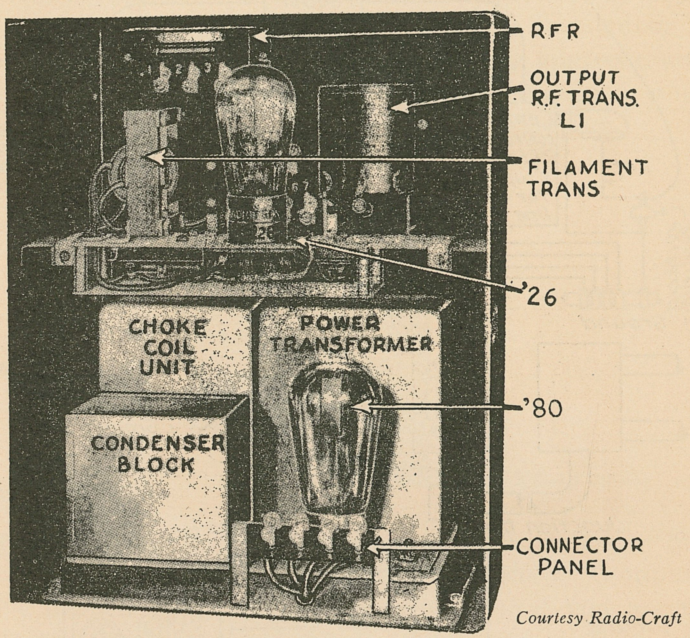
Fig. 55

c. Methods of wiring from the source of power to and between devices, related to apparatus connected to interior wiring systems, shall be in accordance with the rules covering permanent or portable fixtures, devices and appliances.

It is recommended that the authority enforcing this code be freely consulted as to the specific methods to be followed in any case of doubt relative to installation of antenna and counterpoise conductors and that the National Electric Safety Code, Part 5, be followed.

3702. For Receiving Stations Only.

a. Antenna and counterpoise conductor sizes shall be not less than No. 14 if of copper or No. 17 if of bronze or copper-clad steel. Antenna and counterpoise conductors outside buildings shall be kept well away from all electric light



Courtesy Radio-Craft

Fig. 56-A

or power wires of any circuit of more than 600 volts, and from railway, trolley or feeder wires, so as to avoid the possibility of contact between the antenna or counterpoise and such wires under accidental conditions.

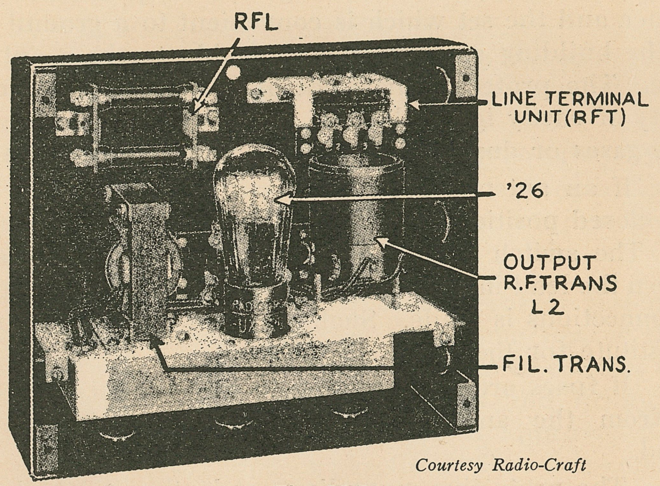
b. Antenna and counterpoise where placed in proximity to electric light or power wires of less than 600 volts, or signal wires, shall be constructed and installed in a strong and durable manner, and shall be so located and provided with suitable clearances as to prevent accidental contact with such wires by sagging or swinging.

c. Splices and joints in the antenna span shall be soldered unless made with approved splicing devices.

d. The preceding paragraphs, a, b, and c, shall not apply to light and power circuits used as receiving antenna, but the devices used to connect the light and power wires to radio receiving sets shall be of approved type.

e. Lead-in conductors, that is, conductors from antennae to sets, shall be of copper, approved copper-clad steel or other metal which will not corrode excessively and in no case shall they be smaller than No. 14, except that bronze or copper-clad steel not less than No. 17 may be used.

f. Lead-in conductors from the antenna to the first building attachment shall conform to the requirements for antennae similarly located. Lead-in conductors from the first



Courtesy Radio-Craft

Fig. 56-B

building attachment to the building entrance shall, except as specified in the following paragraph, be installed and maintained so that they cannot swing closer to open supply conductors than the following distances:

Supply wires 0 to 600 volts............	2 feet
Supply wires exceeding 600 volts........	10 feet

Where all conductors involved are supported so as to insure a permanent separation and the supply wires do not exceed 150 volts to ground, the clearance may be reduced to not less than 4 inches. Lead-in conductors on the outside of buildings shall not come nearer than the clearances specified above to electric light and power wires unless separated therefrom by

a continuous and firmly fixed non-conductor which will maintain permanent separation. The non-conductor shall be in addition to any insulating covering on the wire.

g. Each lead-in conductor shall enter the building through a non-combustible, non-absorptive, insulating bushing slanting upward toward the inside or by means of an approved device designed to give adequate insulation and protection. The lead-in conductor from the building entrance to the set shall have rubber insulation approved for voltages 0-600 (Type R).

h. Each lead-in conductor shall be provided with an approved protective device (lightning arrester) which will operate at a voltage of 500 volts or less, properly connected and located either inside the building at some point between the entrance and the set which is convenient to a ground or outside the building as near as practicable to the point of entrance. The protector shall not be placed in the immediate vicinity of easily ignitable stuff, or where exposed to inflammable gases or dust or flyings of combustible materials.

i. If an antenna grounding switch is employed, it shall in its closed position form a shunt around the protective device. The switch should be placed in the most direct line between the lead-in conductor and the point where the grounding connections is made. Such a switch shall not be used as a substitute for the protective device.

j. If fuses are used, they shall not be placed in the circuit from the antenna through the protective device to ground.

k. The protective grounding conductor may be bare and shall be of copper, bronze or approved copper-clad steel. The protective grounding conductor shall be not smaller nor have less conductance per unit of length, than the lead-in conductor and in no case shall it be smaller than No. 14 if of copper nor smaller than No. 17 if of bronze or copper-clad steel. The protective grounding conductor shall be run in as straight a line as possible from the protective device to a good permanent ground. The ground connections shall be made to a cold-water pipe where such pipe is available and is in service and connected to the street mains. An outlet pipe from a water tank fed from a street main or a well may be used, provided such outlet pipe is adequately bonded to the inlet pipe connected to the street water main or well.

If water pipes are not available, ground connections may be made to a grounded steel frame of a building or to an artificial ground such as a galvanized iron pipe or a rod driven into permanently damp earth or to a metal plate or other body of metal buried similarly. Gas piping shall not be used for the ground.

l. The protective grounding conductor shall be guarded where exposed to mechanical injury. An approved ground clamp shall be used where the protective grounding conductor is connected to pipes or piping.

m. The protective grounding conductor may be run either inside or outside the building. The protective grounding conductor and ground, installed as prescribed in the preceding paragraphs k and l, may be used as the operating ground.

> It is recommended that in this case the operating grounding conductor be connected to the ground terminal of the protective device.
>
> If desired, a separate operating grounding connection and ground may be used, this operating grounding conductor being either bare or provided with an insulated covering.

n. Wires inside buildings shall be securely fastened in a workmanlike manner and shall not come nearer than 2 inches to any electric light or power wire not in conduit unless separated therefrom by some continuous and firmly fixed non-conductor, such as porcelain tubes or approved flexible tubing, making a permanent separation. This non-conductor shall be in addition to any regular insulating covering on the wire.

o. Storage-battery leads shall consist of conductors having approved rubber insulation. The circuit from a filament "A" storage battery of more than 20 ampere hours capacity, NEMA rating, shall be properly protected by a fuse or circuit-breaker rated at not more than 15 amperes. The circuit from a plate, "B" storage battery shall be properly protected by a fuse or circuit-breaker rated at not more than 1 ampere in the negative lead. Fuses or circuit-breakers shall be located not more than 18 inches along the wire from a battery terminal.